'Viscosity'

Viscosity (η) → property of a liquid or gas in which one layer oppose the flow of adjacent layer.
i.e Two layer opposes their Relative motion.

Unit of 'η'

| 1 decapoise = 10 poise |

S.I → poiseuille
C.G.S → poise

Dimension of η

$[ML^{-1}T^{-1}]$

General properties →

|i| → With Rise in density, viscosity of liquid increase but that of gas decrease.
*|ii| → With Rise in temp., viscosity of liq ↓, but that of gas ↑se.
**|iii| → With Rise in pressure, viscosity of liq ↑, but that of gas is independent of pressure.
|iv| → In case of water with Rise in pressure viscosity ↓.
**|v| → Rate of change of speed w.r.t distance measured in perpendicular direction of flow is dv/dy & called velocity greadient.

$$P + \frac{1}{2}\rho v^2 + \rho g h = const = K$$

$$\frac{P}{\rho g} + \frac{v^2}{2g} + h = \frac{K}{\rho g}$$

$\frac{P}{\rho g}$ → Press head; $\frac{v^2}{2g}$ → velo head; h → pot. energy head.

Viscous force $= F \propto A$ (Area)

$$\propto \frac{dv}{dy}$$

$$F \propto A\frac{dv}{dy} \Rightarrow \boxed{F = (-)\eta A \frac{dv}{dy}}$$

(−) → opposing nature of viscous force.

η → cofficient of viscosity.

$\frac{dv}{dy}$ ⇒ velocity greadient.

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Poiseuille formula –

Rate of flow of liquid with respect to time. i.e volume flow in per second. through a capilary tube of Radius 'R', length 'L', when a pressure difference 'p' is applied is given by –

$$\boxed{Q = \frac{\pi P R^4}{8 \eta L}}$$

L → Length of cap.

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Stoke's Law

When force acting on a sphere of radius 'r' moving in liquid with speed V' –

$$F = 6\pi\eta r v$$

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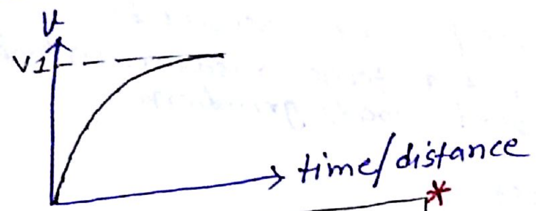
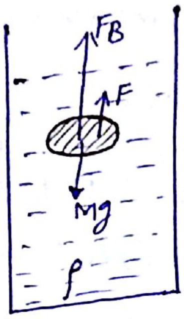
Terminal velocity →

When a spherical object of radius 'r', density 'σ' fall in a liquid of density ρ then Ist velocity ↑ & After some time net force on it becomes zero. so, velocity become const. called terminal velocity.





$$a = \frac{(\rho_s - \rho_L)}{\rho_s} - \frac{9\eta v}{2r^2\rho_s}$$

$$V_T = \frac{2}{9} r^2 \frac{(\sigma - \rho)g}{\eta}$$

If 'n' identical sphere of same material are moving in a liquid with const. speed 'v' are calapsed to form a single sphere, the new const. speed will be.

$$V_T = \frac{2}{9} \frac{(\rho_s - \rho_L)}{\eta} r^2 g$$

$V_T \propto r^2$

$V_T' \propto R^2$

$\frac{V_T'}{V_T} = \left(\frac{R}{r}\right)^2$

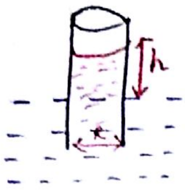
$R = n^{1/3} \cdot r$

$\frac{R}{r} = n^{1/3}$

$\frac{V_T'}{V_T} = n^{2/3}$

$\therefore V_T' = n^{2/3} V$ ***

#** → (i) → Find the rise of liquid level in capillary tube.
(ii) → Find work done by surface tension in this process.
(iii) → Find the ↑ in gravitational pot. energy in this process
(Assume contact Angle is zero)



(i) → * $h = \frac{2\sigma}{\rho g R}$ or, * $h = \frac{2\sigma}{\rho g d}$

(ii) → $W_T = \sigma \times 2\pi R \times \frac{2\sigma}{\rho g R}$

$= \frac{4\pi\sigma^2}{\rho g}$

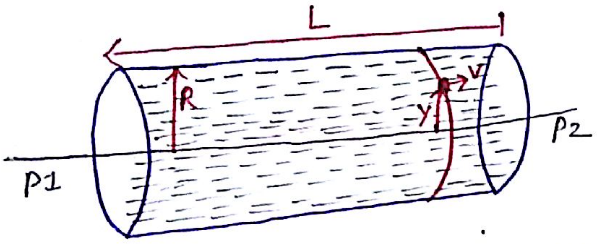
** (iii) → $\Delta U_g = mg\frac{h}{2}$

$\rho \times \pi R^2 h \times g \frac{h}{2}$

$= \frac{\rho g \cdot \pi R^2}{2} \times \frac{4\sigma^2}{\rho^2 g^2 R^2} = \frac{2\pi\sigma^2}{\rho g}$

$W_T = \Delta U_g = \frac{2\pi\sigma^2}{\rho g}$

***
#



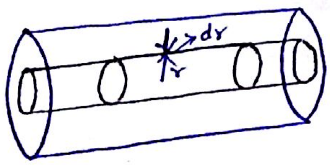
$V = \frac{P}{4\eta L}(R^2 - y^2)$

$P = P_1 - P_2$

* At $y = 0 \Rightarrow V = V_{max} = V_0$
$V_0 = \frac{PR^2}{4\eta L}$

* At $y = R \Rightarrow V = V_{min} = 0$

→



Diff. in K.E $= \pi \rho L \cdot r \cdot dr \left[\frac{P}{4\eta L}(R^2 - r^2)\right]^2$

** $K = \frac{\pi \rho R^6}{96\eta^2 L} P^2$ ** ⇒ Total K.E in pipe

$m_0 = \rho \times \pi R^2 L$

$K = \frac{1}{2} m_0 V_{avg}^2$.